PB85-194660

Polychlorinated Dioxins and Polychlorinated Furans in Fish from the Great Lakes and Midwest

(U.S.) Environmental Protection Agency
Chicago, IL

Oct 84

U.S. Department of Commerce
National Technical Information Service
NTIS

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA - 905/3-84-006		PB85 194660/AS

4. TITLE AND SUBTITLE	5. REPORT DATE
Polychlorinated Dioxins and Polychlorinated Furans in Fish From The Great Lakes Midwest	October 1984
	6. PERFORMING ORGANIZATION CODE: 5GL

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
David DeVault III	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
U.S. Environmental Protection Agency Great Lakes National Program Office 536 South Clark Street, Chicago, Illinois 60605 Chicago, Illinois 60605	11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
U.S. Environmental Protection Agency Great Lakes National Program Office 536 South Clark Street, Chicago, Illinois 60605	Monitoring 1979-1983
	14. SPONSORING AGENCY CODE: Great Lakes National Program Office, U.S. EPA, Region V

15. SUPPLEMENTARY NOTES

David DeVault, Project Officer

16. ABSTRACT

Data on concentrations of polychlorinated dioxins (PCDD) and polychlorinated furans (PCDF) in fish from the Great Lakes and midwest were compiled. While differences in study design precluded rigorus analysis several observation were possible.

Most samples have been analyzed for only 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). Those samples which were analyzed for other congeners indicate that penta and hexachlorodibenzo-p-dioxins are more common than 2,3,7,8-TCDD. PCDD may be ubiquitous in fish from the Great Lakes and midwest, occurring above detection limits in over 80 percent of the samples analyzed. One of several sites at which 2,3,7,8-Tetrachlorodibenzo furan (2,3,7,8-TCDF) was detected is Siswi Lake (Isle Royal, Lake Superior), which suggests atmospheric deposition of PCDFs.

Areas of Concern (due to 2,3,7,8-TCDD concentrations) include the entire Lake Ontario Basin, Saginaw Bay (Lake Huron) and the Saginaw River System, Grand River (Lake Michigan), Niagara River (Lake Ontario), Lake Erie (at Woodtick, Michigan), Huron River, Michigan (Lake Erie), Port Clinton, Michigan (Lake Erie) Wisconsin River (at Pentenwell Flowage), and the Mississippi River (St. Louis, MO).

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Polychlorinated furans Polychlorinated dioxins Fish contaminant		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Document is available to the public through the National Technical Information Service (NTIS), Springfield, VA 22161		49
	20. SECURITY CLASS (This page)	22. PRICE

EPA Form 2220-1 (9-73)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1985—555-847/531

United States
Environmental Protection
Agency

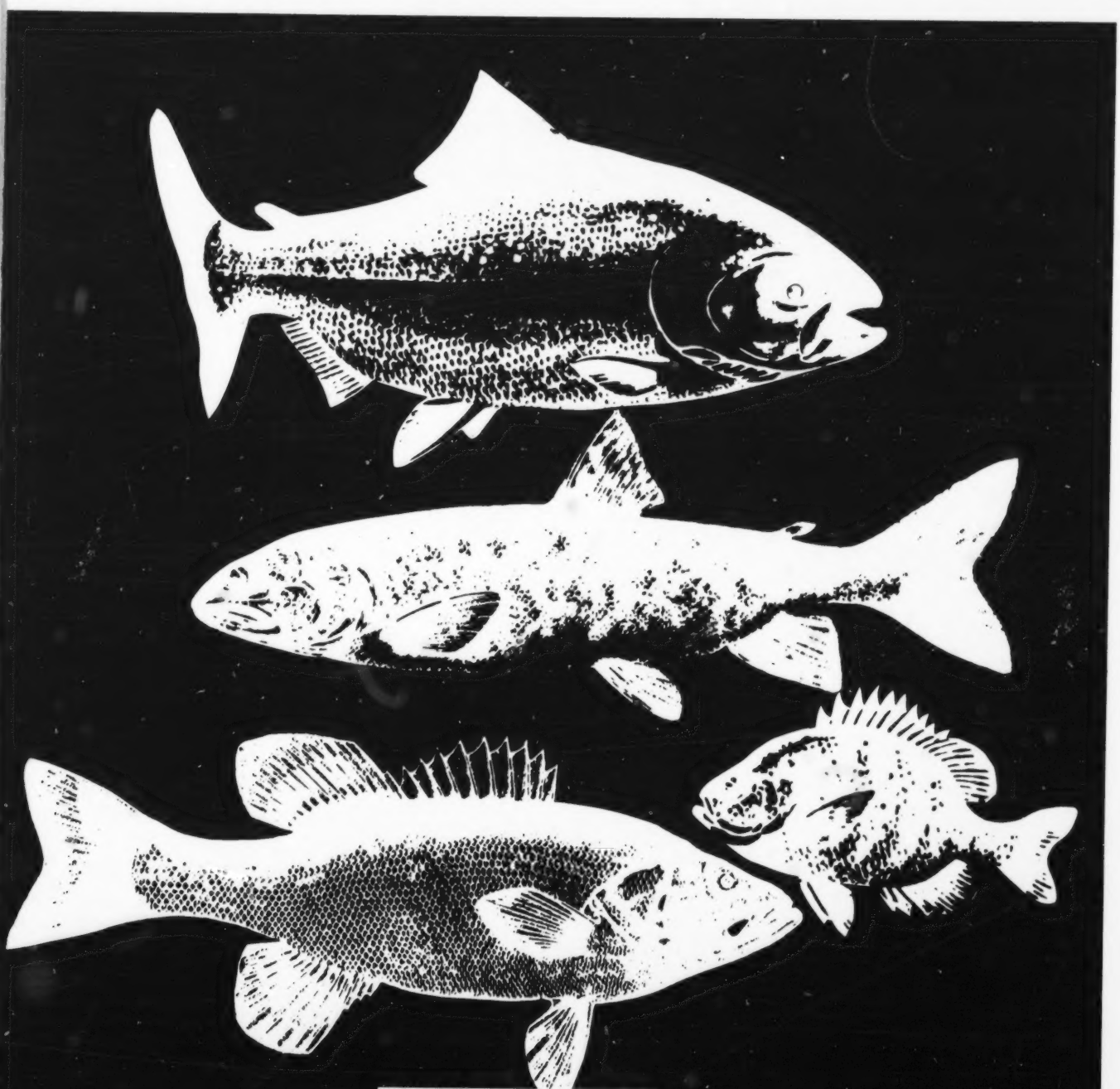
Great Lakes National
Program Office
536 South Clark Street
Chicago, Illinois 60605

EPA-905/3-84-006
October 1984

PB85-194660

EPA

Polychlorinated Dioxins And Polychlorinated Furans in Fish From the Great Lakes and Midwest



REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE

EPA 905/3-84-006
October 1984

POLYCHLORINATED DIOXINS AND POLYCHLORINATED FURANS IN FISH FROM THE GREAT LAKES AND MIDWEST

by

David DeVault

for

U.S. ENVIRONMENTAL PROTECTION AGENCY
GREAT LAKES NATIONAL PROGRAM OFFICE
536 SOUTH CLARK STREET
CHICAGO, ILLINOIS 60605

DISCLAIMER

"This report has completed the EPA peer and publications review process and is approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation by EPA."

FOREWORD

The Great Lakes National Program Office (GLNPO) of the U.S. Environmental Protection Agency was established in Region V, Chicago to focus attention on the significant and complex natural resource represented by the Great Lakes.

GLNPO implements a multi-media environmental management program drawing on a wide range of expertise represented by universities, private firms, State, Federal and Canadian governmental agencies and the International Joint Commission. The goal of the GLNPO program is to develop programs, practices and technology necessary for a better understanding of the Great Lakes system and to eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes system. The GLNPO also coordinates U.S. actions in fulfillment of the Agreement between Canada and the United States of America on Great Lakes Water Quality of 1978.

ABSTRACT

Data on concentrations of polychlorinated dioxins (PCDD) and polychlorinated furans (PCDF) in fish from the Great Lakes and midwest were compiled from several sources. While differences in study design precluded rigorus analysis several observation were possible.

While most samples have been analyzed for only 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), those samples which were analyzed for other congeners indicate that penta and hexachlorodibenzo-p-dioxins are more common than 2,3,7,8-TCDD. PCDD, while monitored infrequently, may be ubiquitous in fish from the Great Lakes and midwest, occurring above detection limits in over 80 percent of the samples analyzed. One of several sites at which 2,3,7,8-Tetrachlorodibenzo furan (2,3,7,8-TCDF) was detected is Siskwit Lake (Isle Royal, Lake Superior), which given its remote location and lack of point sources, suggests atmospheric deposition of PCDFs.

Areas of Concern (due to 2,3,7,8-TCDD concentrations) include the entire Lake Ontario Basin, Saginaw Bay (Lake Huron) and the Saginaw River System, Grand River (Lake Michigan), Niagara River (Lake Ontario), Lake Erie (at Woodtick, Michigan), Huron River, Michigan (Lake Erie), Port Clinton, Michigan (Lake Erie), Wisconsin River (at Pentenwell Flowage), and the Mississippi River (St. Louis, MO.).

CONTENTS

Foreword	iii
Abstract	iv
Tables	vi
Acknowledgements	vii
Introduction	1
Data Presentation	2
Polychlorinated Dioxins	4
Polychlorinated Furans	25
Discussion	35
Literature Cited	39

TABLES

		PAGE
Table 1:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Dioxin in Lake Superior Fish	5
Table 2:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Dioxin in Lake Huron Fish	6
Table 3:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Dioxin in Lake Saginaw Bay Fish	8
Table 4:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Dioxin in Lake Michigan Fish	12
Table 5:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Dioxin in Lake Erie Fish	15
Table 6:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Dioxin in Lake Ontario Fish	18
Table 7:	Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Fish From Midwest Rivers and Lakes	21
Table 8:	Polychlorinated Dibenzo Dioxins in Great Lakes and Midwest Fish	24
Table 9:	Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan in Lake Superior Fish	26
Table 10:	Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan in Lake Huron Fish	27
Table 11:	Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan in Lake Michigan Fish	28
Table 12:	Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan in Lake Erie Fish	30
Table 13:	Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan in Lake Ontario Fish	31
Table 14:	Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan in Fish From Midwest Rivers and Lakes	32
Table 15:	Polychlorinated Dibenzo Furans in Great Lakes and Midwest Fish	33
Table 16:	Data Contributors	38

ACKNOWLEDGEMENTS

First and Foremost, I thank the many individuals and organizations who made this report possible by sharing their data. I also would like to thank Mr. Lee Liebenstein (Wisconsin Department of Natural Resources), Mr. Dennis Swanson (Michigan Department of Natural Resources) and Dr. John Estenik (Ohio EPA) for reviewing and commenting on the manuscript. I also thank Ms. Gaynell Whatley for her patience in typing the manuscript.

INTRODUCTION

Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) are two groups of tricyclic aromatic compounds with similar chemical, biological and toxicological properties (Poland et at. 1979, Rappe et al. 1979). The occurrence of both classes of compounds in environmental samples have been the subject of much concern in recent years, primarily due to the extremely high mammalian toxicity of some of the specific isomers (Poland et al. 1979). This concern has resulted in several studies to monitor levels of these compounds in fish from the Great Lakes and other waterways since 1978. While most studies have monitored concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin, (the most toxic isomer of either group), limited data are available for other dioxin congeners, as well as PCDF's. Unfortunately, with the exception of 2,3,7,8,-TCDD and 2,3,7,8-TCDF, the existing data are not isomer specific.

This report was prepared as a part of the USEPA Region V, Dioxin Task Force's contribution to USEPA's National Dioxin Strategy. Its purposes are to, 1) compile the existing data on PCDD and PCDF in fish from the Great Lakes and Midwest, 2) identify areas with existing PCDD and PCDF fish contaminant problems, and 3) identify additional data requirements.

DATA PRESENTATION

The data are presented by lake or river basin. Due to the large quantity of data and concern over PCDD in Saginaw Bay and its tributaries, that information has been presented as a separate basin.

Within each basin, the data is subdivided into an "open lake" and a "nearshore and tributary" section. This is an artifical division based on the habits of the species analyzed rather than the area in which it was collected. "Open lake" species are those which range over large geographical areas and thus may acquire contaminants from numerous sources. Included in this category are species such as brown trout which, while usually remaining nearshore, cover long stretches of coast line as well as coho salmon and lake trout which move about the open waters of the Great Lakes. The "nearshore and tributary" category includes species which are likely to remain in a fairly confined geographical area for substantial periods of time. These would include bass and carp from river mouths and embayments as well as carp and catfish from specific sites in the open waters of Saginaw Bay. The number of samples represented by mean values and the number of fish in composite samples are given when such information was available. When it was not, it was omitted and each data point was considered a single sample. Omission of this data is not important, given the heterogenicity of sample type, species and analytical methodologies used in the various studies.

The sample portion analyzed has been indicated for each data point. For whole fish this is self explanatory, however edible portions vary from agency to agency. The Ontario Ministry of the Environment analyzes a skinless dorsal fillet, while the U.S. Food and Drug Administration (USFDA) analyzes a

skin-on lateral fillet for most species. The USFDA analyzes a skin-off lateral fillet for species such as bullheads and catfish for which the skin is considered inedible. The data furnished by Michigan State University (MSU 1979), as well as samples analyzed by the New York State Departments of Environmental Conservation and Health (NYDEC/NYDOH) were analyzed as skin-off fillets (O'keefe et al. 1983). Based on PCB and DDT analysis of coho and chinook salmon, a skin-off fillet can be expected to yield results one third to one half that found in a skin-on fillet (Rohrer et al. 1981).

The U.S. Food and Drug Administration (USFDA), the New York State Department of Health (NYSDOH) and Health and Welfare Canada (HWC) have established guidelines or action limits for 2,3,7,8-tetrachlorodibenzo-p-dioxin in edible portions of fish and shellfish. These guidelines are:

USFDA - limit consumption to 1 meal (1/2 lb) per week at concentrations $\geq$ 25 ng/kg and avoid consumption at concentrations $\geq$ 50 ng/kg

NYDOH - avoid consumption at concentrations $\geq$ 10 ng/kg.

Health and Welfare Canada - avoid consumption at concentrations $\geq$ 20 ng/kg.

Due to the differences in edible portion analyzed, the USFDA and HWC limits probably represent similar human exposure. The NYDOH limit is substantially more conservative. There are presently no guidelines for other dioxin isomers or furans.

As much of the data has not been published in the scientific literature and was frequently produced under contract to government agencies, the organization supplying the data and the year of the study are indicated in the data tables rather than individual authors. Table 16 lists the organizations supplying data.

POLYCHLORINATEDIBENZO DIOXINS

Tables 1 through 7 contain the data on 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and, where data is available, total tetrachlorodibenzo-p-dioxins (TCDD) and total polychlorinated dibenzo-p-dioxin (PCDD). Table 8 contains the data on those samples which were analyzed for individual congeners.

Lake Superior

Fifteen samples representing 8 areas of the open waters of Lake Superior were analyzed between 1979 and 1983 (Table 1). Two samples representative of St. Louis River and Bay were also analyzed. Of the 15 samples from Lake Superior which have been analyzed, only 1 sample of whole lake trout taken off Ontonagon yeilded TCDD or PCDD above detection limits. This sample contained 8 ng/kg total PCDD of which 5 ng/kg was pentachlorodibenzo-p-dioxin (penta-CDD) (Table 8). The St. Louis River samples were also below detection limits for 2,3,7,8-TCDD. However, analysis was not conducted for congeners other than 2,3,7,8-TCDD.

Lake Huron

The Lake Huron (not including Saginaw Bay) data base consists of 22 samples from 7 open lake areas and 9 samples from 6 nearshore and tributary sites (Table 2). With the exception of 1 edible portion sample from Alpena, Michigan concentrations were below detection limits, which ranged from 8 to 88 ng/kg. No whole fish have been analyzed for dioxin nor have samples been analyzed for dioxins other than 2,3,7,8-TCDD.

Saginaw Bay

The 10 edible portion samples from the open waters did not contain TCDD above detection limits which ranged from 10 to 16 ng/kg. Concentrations in nearshore and tributary fish from the Bay were also typically low with

Table 1
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Superior Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Open Lake							
Keweenaw	Bloater	W	1/5	NA	ND	ND	USFWS 1979 (1)
Apostle Islands	Lake Trout	W	1/5	NA	ND	ND	USFWS 1979 (1)
	Lake Trout	E	1/5	<10	ND	NA	GLNPO/USFDA 1982
Ontonagon	Lake Trout	W	1/1	NA	1	8	USEPA-Duluth 1980 (1)
Grand Marais	Lake Trout/Salmon	W	1/3+3	NA	<1	<1	USEPA-Duluth 1980 (1)
Copper Harbor	Lake Trout	W	1/2	NA	<1	<1	USEPA-Duluth 1980 (1)
Thunder Bay	Lake Trout	E	6/1	<10	NA	NA	MOE 1980
French River	Lake Trout	E	1/6	<5	NA	NA	USEPA-Duluth 1983
St. Louis Bay	Walleye	E	1/5	<5	NA	NA	USEPA-Duluth 1983
	Walleye	E	1/5	<10	NA	NA	WDNR 1983
Nearshore and Tributary							
St. Louis River							
Thompson Res.	White Sucker	E	1/6	<5	NA	NA	USEPA-Duluth 1983
Upper Bay	White Sucker	E	1/5	<5	NA	NA	USEPA-Duluth 1983

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 8

E = Edible portion
W = Whole fish

Table 2
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Huron Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Open Lake							
Tawas Pt.	Yellow Perch	E	1/U	<8	NA	NA	WSU 1979
Grid 1509	Yellow Perch	E	1/U	<11	NA	NA	WSU 1979
Pt. Edward	Lake Trout	E	6/1	<10	NA	NA	MOE 1980
Owen Sound	Rainbow Trout	E	6/1	<10	NA	NA	MOE 1980
St. Joseph Is.	Walleye	E	6/1	<10	NA	NA	MOE 1980
Tawas River	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA 1982
Alpena, Michigan	Lake Trout	E	1/5	6	NA	NA	GLNPO/USFDA 1982
Nearshore and Tributary							
Au Gres	Catfish	E	1/U	<8	NA	NA	WSU 1979
	Carp	E	1/U	<14	NA	NA	WSU 1979
Sebewaing	Catfish	E	1/U	<11	NA	NA	WSU 1979
	Carp	E	1/U	<5	NA	NA	WSU 1979
Sand Pt.	Catfish	E	1/U	<30	NA	NA	WSU 1979
Tawas Pt.	Carp	E	1/U	<25	NA	NA	WSU 1979
Black River	White Sucker	E	1/U	<88	NA	NA	MSU 1979
at Tower, MI	White Sucker	E	1/U	<13	NA	NA	MSU 1979
Au Sable River	Carp	E	1/8	<10	NA	NA	USFDA 1983

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 8

E = Edible portion
W = Whole fish

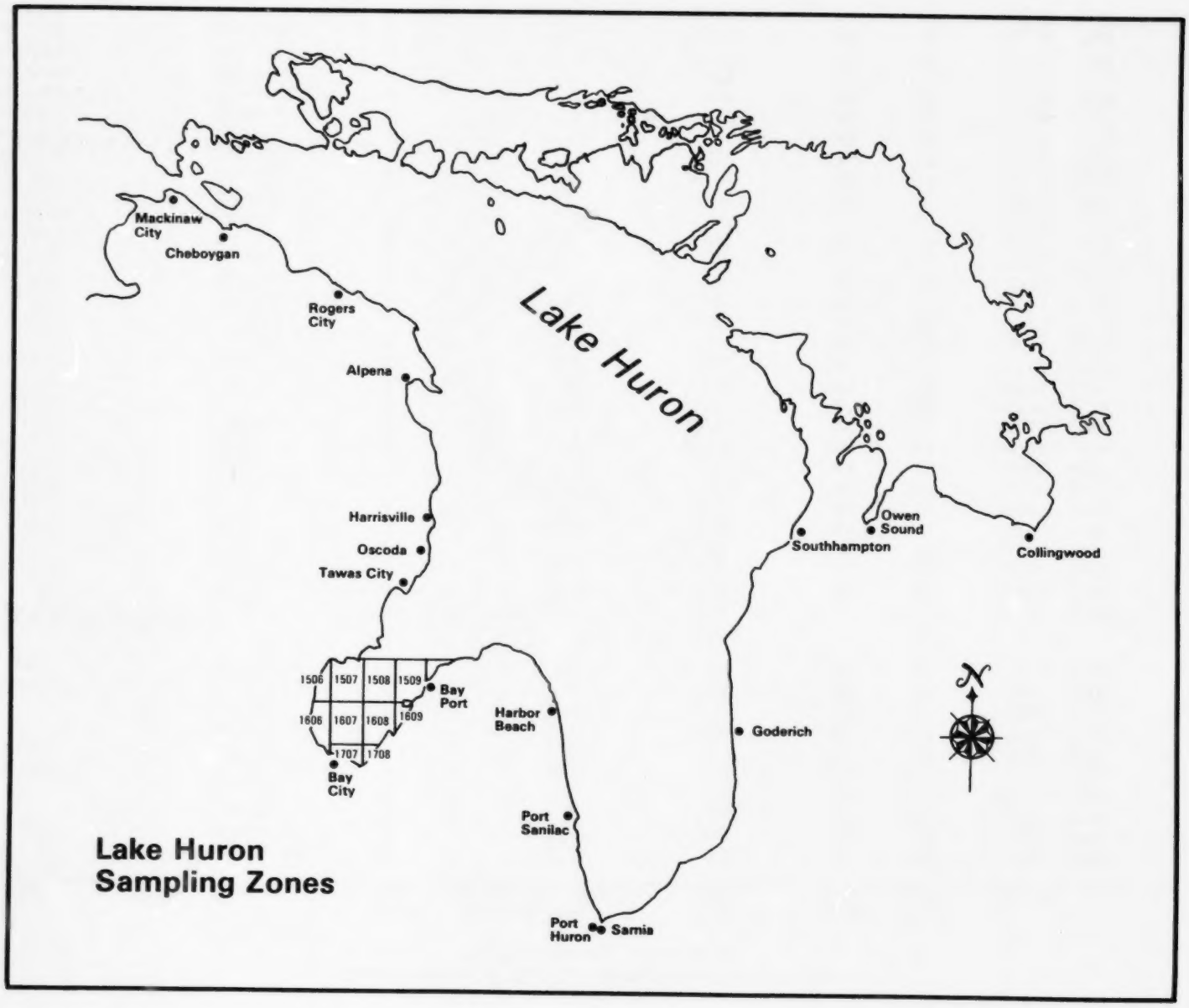

Lake Huron
Mackinaw City
Cheboygan
Rogers City
Alpena
Harrisville
Oscoda
Tawas City
Bay Port
Harbor Beach
Port Sanilac
Bay City
Port Huron
Sarnia
Goderich
Southhampton
Owen Sound
Collingwood
1506
1507
1508
1509
1606
1607
1608
1609
1707
1708
N
Lake Huron
Sampling Zones

Table 3
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Saginaw Bay Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source	
Open Lake								
Grid 1509	Yellow Perch	E	1/24	<10	NA	NA	USFDA	1978
Grid 1507	Yellow Perch	E	1/24	<10	NA	NA	USFDA	1978
	Bowfin	E	1/1	<10	NA	NA	USFDA	1979
	Walleye	E	1/1	<10	NA	NA	USFDA	1984
Grid 1509	Yellow Perch	E	1/24	<10	NA	NA	USFDA	1978
Grid 1509	Yellow Perch	E	1/5	<10	NA	NA	USFDA	1979
	Whitefish	E	1/1	<10	NA	NA	USFDA	1979
	Buffalo	E	1/1	<10	NA	NA	USFDA	1979
Shebewaing	Yellow Perch	E	1/1	<16	NA	NA	WSU	1979
Aus Gres	Yellow Perch	E	1/1	<15	NA	NA	WSU	1979
Nearshore and Tributary								
Grid 1506	Sucker	E	1/12	<10	NA	NA	USFDA	1978
Grid 1506	Sucker	E	1/13	<10	NA	NA	USFDA	1978
Grid 1506	Catfish	E	1/7	<10	NA	NA	USFDA	1978
Grid 1506	Catfish	E	1/14	14/15	NA	NA	USFDA	1978
Grid 1506	Carp	E	1/2	<10	NA	NA	USFDA	1980
Grid 1506	Carp	E	1/2	<10	NA	NA	USFDA	1980
Grid 1507	Sucker	E	1/10	<10	NA	NA	USFDA	1978
Grid 1507	Carp	E	1/7	<10	NA	NA	USFDA	1978
Grid 1507	Carp	E	1/2	16/20	NA	NA	USFDA	1979
Grid 1507	Catfish	E	1/1	35/45	NA	NA	USFDA	1979
Grid 1507	Carp	E	1/1	17/21	NA	NA	USFDA	1979
Grid 1507	Carp	E	1/1	<10	NA	NA	USFDA	1979
Grid 1507	Sucker	E	1/2	<10	NA	NA	USFDA	1979
Grid 1507	Crappie	E	1/1	<10	NA	NA	USFDA	1979
Grid 1507	Rockbass	E	1/1	<10	NA	NA	USFDA	1979
Grid 1507	Bullhead	E	1/1	<10	NA	NA	USFDA	1979
Grid 1507	Bullhead	E	1/1	<10	NA	NA	USFDA	1979
Grid 1509	Sucker	E	1/12	<10	NA	NA	USFDA	1978
Grid 1509	Carp	E	1/1	<10	NA	NA	USFDA	1978
Grid 1509	Carp	W	1/3-5	NA	27	111	USFWS	1979 (1)
Grid 1509	Catfish	E	1/1	29/32	NA	NA	USFDA	1979
Grid 1509	Catfish	E	1/1	26/24	NA	NA	USFDA	1979
Grid 1509	Catfish	E	1/3	<10	NA	NA	USFDA	1979
Grid 1509	Carp	E	1/3	<10	NA	NA	USFDA	1979
Grid 1509	Sucker	E	1/2	<10	NA	NA	USFDA	1979
Grid 1509	Bullhead	E	1/1	<10	NA	NA	USFDA	1979
Grid 1509	Bullhead	E	1/1	<10	NA	NA	USFDA	1979
Grid 1509	Catfish	E	1/10	13/12	NA	NA	USFDA	1980
Grid 1509	Catfish	E	1/10	13/14	NA	NA	USFDA	1980
Grid 1509	Carp	E	1/3	68/62	NA	NA	USFDA	1981

Table 3 con't
Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Saginaw Bay Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source	
Nearshore and Tributary								
Near Saginaw River	Carp	E	1/U	43	NA	NA	MSU	1979
Near Saginaw River	Carp	E	1/U	173	NA	NA	MSU	1979
Near Saginaw River	Carp	E	1/U	28	NA	NA	MSU	1979
Near Saginaw River	Carp	E	1/U	<50	NA	NA	MSU	1979
Bay City	Carp	W	1/1	NA	94	385	USFWS	1981 (1)
Tittabawasse River								
5 Miles upstream of DOW	White Sucker	E	1/U	287	NA	NA	MSU	1979
	Carp	E	1/U	20	NA	NA	MSU	1979
	White Sucker	E	1/U	<63	NA	NA	MSU	1979
Tittabawasse Rd.	Carp	E	1/1	52	NA	NA	USEPA	1978
	Yellow Perch	E	1/1	20	NA	NA	USEPA	1978
	Carp	E	1/1	93	NA	NA	USEPA	1978
Freeland Rd.	Carp	E	1/1	32	NA	NA	USEPA	1978
	Yellow Perch	E	1/1	10	NA	NA	USEPA	1978
	Carp	E	1/U	66	NA	NA	MSU	1979
Smith's Crossing Rd.	Channel Cat	E	1/1	273	NA	NA	USEPA	1978
	Carp	E	1/1	22	NA	NA	USEPA	1978
	Channel Cat	E	1/1	695	NA	NA	USEPA	1978
	Carp	E	1/1	49	NA	NA	USEPA	1978
	Sucker	E	1/1	8	NA	NA	USEPA	1978
	Sucker	E	1/1	21	NA	NA	USEPA	1978
State Street	Yellow Perch	E	1/2	20	NA	NA	USEPA	1978
	Carp	E	1/1	93	NA	NA	USEPA	1978
Above Dow Dam	Channel Catfish	E	1/1	42	NA	NA	USEPA	1978
	Carp	E	1/1	<5	NA	NA	USEPA	1978
	Carp	E	1/1	<9	NA	NA	USEPA	1978
	Channel Catfish	E	1/1	28	NA	NA	USEPA	1978
	Yellow Perch	E	1/1	<4	NA	NA	USEPA	1978
Dublin Rd.	Carp	E	1/1	<9	NA	NA	USEPA	1978
Below Dow	Carp	W	1/3-2	NA	81	223	USFWS	1979 (1)
	Carp	E	1/U	17	NA	NA	MSU	1979
	Carp	E	1/U	39	NA	NA	MSU	1979
	Carp	E	1/U	83	NA	NA	MSU	1979
	Carp	E	1/U	<54	NA	NA	MSU	1979
Consumers Power Plant	Carp	E	1/U	301	NA	NA	MSU	1979
	Carp	E	1/U	129	NA	NA	MSU	1979
Below Saginaw WWTP	White Sucker	E	1/U	64	NA	NA	MSU	1979
	Carp	E	1/U	126	NA	NA	MSU	1979
	Carp	E	1/U	135	NA	NA	MSU	1979

Table 3 con't
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Saginaw Bay Fish

Open Lake

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Sources
Saginaw River							
Saginaw WWTP	Carp	E	1/U	319	NA	NA	MSU 1979
Wickes Park	Carp	E	1/1	62	NA	NA	USEPA 1978
	Yellow Perch	E	1/2	<11	NA	NA	USEPA 1978
Wicks Park	Carp	E	1/U	<35	NA	NA	MSU 1979
Blocks Marina	Channel Catfish	E	1/1	105	NA	NA	USEPA 1978
	Channel Catfish	E	1/1	52	NA	NA	USEPA 1978
	Carp	E	1/1	28	NA	NA	USEPA 1978
Mouth	Channel Catfish	E	1/1	30	NA	NA	USEPA 1978
	Carp	E	1/1	153	NA	NA	USEPA 1978
	Yellow Perch	E	1/2	11	NA	NA	USEPA 1978
Mouth	Carp	E	1/U	288	NA	NA	MSU 1979
Sand Point	Carp	E	1/U	<14	NA	NA	MSU 1979
	Carp	E	1/8	<10	NA	NA	USFDA 1983
Chippewa River							
10 miles upstream of Dow	Carp	E	1/U	136	NA	NA	MSU 1979
Pine River							
Below St. Louis	Carp	E	1/U	322	NA	NA	MSU 1979
	White Sucker	E	1/U	85	NA	NA	MSU 1979
Alma	Carp	E	1/U	<10	NA	NA	USFDA 1983
Cass River							
Frankenmurth	Redhorse Sucker	E	1/U	<40	NA	NA	MSU 1979
	Carp	E	1/U	< 9	NA	NA	MSU 1979
	Carp	E	1/8	<10	NA	NA	USFDA 1983
Flint River							
Below Flint	Carp	E	1/U	<100	NA	NA	MSU 1979
	Carp	E	1/8	<10	NA	NA	USFDA 1983
Holloway Reservoir	White Sucker	E	1/U	<24	NA	NA	MSU 1979
Shiawassee River							
Chesning	Carp	E	1/8	<10	NA	NA	USFDA 1983

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Addition Congeners in Table 8

E = Edible portion
W = Whole fish

most samples below 10 ng/kg (Table 3). However, elevated concentrations occurred in fillets and whole fish from grids 1506, 1507, 1509 and at the mouth of the Saginaw River (Figure 1). The most seriously contaminated area of the Bay was grid 1509 where 80 percent of the catfish and 60 percent of the carp which have been analyzed exceeded 10 ng/kg.

Concentrations of 2,3,7,8-TCDD in Saginaw Bay tributaries ranged from <4 ng/kg in yellow perch above the Dow Dam in the Tittabawasse to 695 ng/kg in channel catfish at Smiths Crossing Road. Elevated concentrations of 2,3,7,8-TCDD have been monitored in fish at all sites in the Tittabawasse and Saginaw Rivers.

Three samples, a composite of whole carp from grid 1509, a single whole carp taken off Bay City, Michigan, and a whole carp composite from below Dow in the Tittabawasse River, have been analyzed for dioxins other than 2,3,7,8-TCDD. The Tittabawasse River sample was dominated by TCDD while the Bay City and Grid 1509 sample were dominated by Penta (Penta CDD) and Octachlorodibenzo-p-dioxin respectively (Octa CDD) (Table 8).

Lake Michigan

Despite the active sport fishery and large concentration of industry in the Lake Michigan basin, only 12 samples from 6 open lake areas have been analyzed. Concentrations in those open lake samples which have beee analyzed are low, with only a single whole lake trout composite exceeding detection limits (Table 4).

Table 4
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Michigan Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Open Lake							
Saugatuck	Lake Trout	E	1/1	<7.9	NA	NA	USEPA 1978
	Lake Trout	W	1/5	NA	5.0	5.0	USFWS 1979(1)
	Lake Trout	E	1/5	<10	NA	NA	GLNPO/USFDA 1982
St. Joseph River	Coho Salmon	E	1/1	<4.8	NA	NA	NYDOH 1979
	Coho Salmon	E	1/1	<3.1	NA	NA	NYDOH 1979
	Coho Salmon	E	1/1	<4.0	NA	NA	NYDOH 1979
	Coho Salmon	E	1/1	<4.9	NA	NA	NYDOH 1979
	Coho Salmon	E	1/1	<2.0	NA	NA	NYDOH 1979
Platte River	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA 1982
Kellogg River	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA 1982
Sheboygan River	Chinook	E	1/1	<5.0	NA	NA	WDNR 1983
Kenosha	Lake Trout	E	1/2	<25.0	NA	NA	WDNR 1983
Green Bay							
Fox River	Walleye	W	1/5	<5	NA	NA	USEPA-Duluth 1983
Grid 1001	Walleye	E	1/2	<5	NA	NA	WDNR 1983
Little Sturgeon Bay	Walleye	E	1/5	<5	NA	NA	WDNR 1983
Nearshore and Tributary							
White River							
White Lake	White Sucker	E	1/U	<48	NA	NA	MSU 1979
	Carp	E	1/U	<34	NA	NA	MSU 1979
Muskegon River							
Muskegon Lake	Carp	E	1/U	<10	NA	NA	USFDA 1984
US Rt. 131	White Sucker	E	1/U	<56	NA	NA	MSU 1979
Bridgetown	Carp	E	1/U	237	NA	NA	MSU 1979
Cobb Power Plant	Redhorse	E	1/U	123	NA	NA	MSU 1979
Rodgers Dam	Carp	E	1/U	<10	NA	NA	USFDA 1983
	Carp	E	1/U	<51	NA	NA	MSU 1979
	Carp	E	1/U	<10	NA	NA	USFDA 1984
Grand River							
Grand Ledge	Carp	E	1/U	298	NA	NA	MSU 1979
	Carp	E	1/8	<10	NA	NA	USFDA 1983
Eagle	Carp	E	1/1	20	NA	NA	USEPA 1979
	Carp	E	1/1	41	NA	NA	USEPA 1979
	Channel Catfish	E	1/1	29	NA	NA	USEPA 1979
	Smallmouth Bass	E	1/1	7	NA	NA	USEPA 1979
	Smallmouth Bass	E	1/1	8	NA	NA	USEPA 1979
Iona	Carp	E	1/1	<2	NA	NA	USEPA 1979
	Sucker	E	1/1	<2	NA	NA	USEPA 1979

Table 4 con't
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Michigan Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Springlake	Carp	E	1/U	324	NA	NA	MSU 1979
	Carp	E	1/U	<38	NA	NA	MSU 1979
	Carp	E	1/U	<173	NA	NA	MSU 1979
	Redhorse	E	1/U	<20	NA	NA	MSU 1979
Waukegan Harbor	Carp	W	1/1	NA	ND	ND	USFWS 1981(1)
	Largemouth Bass	W	1/1	NA	ND	37	USFWS 1981(1)
Kalamazoo River							
Saugatuck	Carp	E	1/U	2.4	NA	NA	MSU 1979
	Carp	E	1/U	<21	NA	NA	MSU 1979
	Carp	E	1/U	<5	NA	NA	MSU 1979
	Carp	E	1/U	<115	NA	NA	MSU 1979
	White Sucker	E	1/U	<33	NA	NA	MSU 1979
	White Sucker	E	1/U	<76	NA	NA	MSU 1979
Milwaukee River	Carp	E	1/3	<10	NA	NA	WDNR 1983
(below N. Ave.)			1/U				
Sheboygan River	Carp	E	1/3	<10	NA	NA	WDNR 1983
Green Bay			1/U				
DePere	Carp	W	1/5	< 5	NA	NA	USEPA-Duluth 1983
Little Lake Butte	Carp	E	1/6	< 6	NA	NA	WDNR 1983
Des Mortes	Walleye	E	1/5	< 9	NA	NA	WDNR 1983
Grid 1001	Carp	E	1/5	< 5	NA	NA	WDNR 1983
Kidney Island	Carp	E	1/2	<15	NA	NA	WDNR 1983
Little Sturgeon Bay	Carp	E	1/5	<13	NA	NA	WDNR 1983

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 8

E = Edible portion
W = Whole fish

Analysis of nearshore and tributary areas of Lake Michigan consist of samples from White Lake (MI), Muskegon River (MI), Grand River (MI), Waukegan Harbor (IL), and the Kalmazoo River (MI). Concentrations of total PCDD in Waukegan Harbor were ND and 37 ng/kg in whole carp and largemouth bass respectively. Neither Waukegan Harbor sample contained detectable concentrations of 2,3,7,8-TCDD. In the Muskegan River, 2,3,7,8-TCDD ranged from <56 ng/kg in white sucker fillets at U.S. Route 131 to 237 ng/kg in carp fillets at Bridgetown. Concentrations of 2,3,7,8-TCDD in White Lake and the Kalamazoo River were below detection limits in both carp and suckers.

Several sites on the Grand River from Grand Ledge to Spring Lake have been sampled. Concentrations of TCDD ranged from 20 ng/kg to 298 ng/kg in carp fillets at Grand Ledge and Eagle. At Spring Lake concentrations in redhorse sucker and carp fillets ranged from <20 ng/kg TCDD to 324 ng/kg TCDD. At the intermediate Ionia site, carp and suckers both yeilded <2.0 ng/kg TCDD, indicating that contamination may be confined to specific river reaches.

Three composite samples from 3 open water areas of Green Bay were collected in 1983 (Table 4). All contained <3 ng/kg 2,3,7,8-TCDD. Nearshore and tributary samples from the Fox River and Green Bay were also below detection limits that ranged from 5 to 13 ng/kg. No samples from Green Bay have been analyzed for dioxins other than 2,3,7,8-TCDD.

Lake Erie

Concentrations of 2,3,7,8-TCDD in open lake fish from Lake Erie were low, ranging from 0.9 ng/kg to <10 ng/kg (Table 5). Most nearshore and tributary fish from Lake Erie also contained only low levels of 2,3,7,8-TCDD. However,

Table 5
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Erie Fish (ng/kg)

Location	Species	Sample Type	#of Samples #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source	
Open Lake								
Belle Isle	Coho Salmon	E	1/U	0.9	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	1.9	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	1.4	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	<1.0	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	<5.0	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	<1.0	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	<3.7	NA	NA	NYDEC/NYDOH	1979
Belle Isle	Coho Salmon	E	1/U	<7.0	NA	NA	NYDEC/NYDOH	1979
Monroe, MI	Walleye	E	1/U	2.6	NA	NA	NYDEC/NYDOH	1979
Monroe, MI	Walleye	E	1/U	2.6	NA	NA	NYDEC/NYDOH	1979
Dunkirk	Walleye	E	1/U	<2.0	NA	NA	NYDEC/NYDOH	1979
Dunkirk	Walleye	E	1/U	<2.7	NA	NA	NYDEC/NYDOH	1979
Dunkirk	Walleye	E	1/U	<3.4	NA	NA	NYDEC/NYDOH	1979
Port Dover	Rainbow Trout	E	3/1	<10	NA	NA	MOE	1980
Detroit River	Yellow Perch	E	3/1	<10	NA	NA	MOE	1980
Upper Niagara	Yellow Perch	E	6/1	<10	NA	NA	MOE	1980
Detroit River	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA	1982
Huron River, Ohio	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA	1982
Trout River, Pa.	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA	1982
Charqin River, Ohio	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA	1982
Nearshore and Tributary								
Belle River Gratiot Road	White Sucker	E	1/U	<76	NA	NA	MSU	1979
Clinton River, MI Avon Road	White Sucker	E	1/U	<45	NA	NA	MSU	1979
Huron River, MI Superior Road	Carp	E	1/U	<90	NA	NA	MSU	1979
Flat Road	Catfish	E	1/U	<50	NA	NA	MSU	1979
	Carp	E	1/U	246	NA	NA	MSU	1979
Raisin River Monroe	Carp	E	1/U	<52	NA	NA	MSU	1979
	Carp	E	1/U	<127	NA	NA	MSU	1979
Detroit River Belle Isle	Carp	E	1/U	<44	NA	NA	MSU	1979

Table 5 con't
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Erie Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source	
Athol Springs	Smallmouth Bass	E	1/U	<1.5	NA	NA	NYDEC/NYDOH	1979
	Smallmouth Bass	E	1/U	<3.2	NA	NA	NYDEC/NYDOH	1979
	Smallmouth Bass	E	1/U	1.6	NA	NA	NYDEC/NYDOH	1979
	Carp/Goldfish	E	1/U	<2.6	NA	NA	NYDEC/NYDOH	1979
Port Clinton, MI	Carp	W	1/3-5	ND	NA	50	USFWS	1979(1)
	Carp	E	1/U	<30	NA	NA	MSU	1979
	Carp	E	1/U	<18	NA	NA	MSU	1979
	Carp	E	1/U	<11	NA	NA	MSU	1979
	Carp	E	1/U	75	NA	NA	MSU	1979
St. Clair River	Carp	E	1/8	<10	NA	NA	USFDA	1983
Lake St. Clair	Catfish	W	1/2	NA	7	35	USEPA-Duluth	1980(1)
Woodtick, MI	Carp	W	1/3	NA	12	106	USEPA-Duluth	1980(1)
Upper Niagara	White Sucker	E	1/1	<10	NA	NA	MOE	1980
Upper Niagara	Smallmouth Bass	E	1/1	<10	NA	NA	MOE	1980
Fort Erie	Spottail Shinners	W	7/10	15	NA	NA	MOE	1980
Love Canal	Spottail Shinners	W	7/10	7.5	NA	NA	MOE	1980
Cayuga Creek	Spottail Shinners	W	7/10	59	NA	NA	MOE	1980
Nanticoke	Spottail Shinners	W	7/10	ND	NA	NA	MOE	1980
Grand River								
Diamond Shamrock Corporation	Carp		1/U	<5	NA	NA	USEPA-Duluth	1984
	Black Redhorse		1/U	<5	NA	NA	USEPA-Duluth	1984
	Rockbass		1/U	<5	NA	NA	USEPA-Duluth	1984
	Smallmouth Bass		1/U	<5	NA	NA	USEPA-Duluth	1984
	Pumpkinseed		1/U	<5	NA	NA	USEPA-Duluth	1984
Fields Brook	Largemouth Bass		1/U	<5	NA	NA	USEPA-Duluth	1984
Ashtabula, Ohio	Goldfish		1/U	<5	NA	NA	USEPA-Duluth	1984

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 8

E = Edible portion
W = Whole Fish

samples from Lake St. Clair, Port Clinton (MI), Woodtick (MI) and the Huron River (MI) contained TCDD in concentrations ranging from 7 ng/kg in Lake St. Clair to 246 ng/kg in the Huron River. Three Lake Erie samples (Woodtick (MI), Port Clinton (MI), and Lake St. Clair) have been analyzed for dioxins other than 2,3,7,8-TCDD. In all three samples hepta and octachlorodibenzo-p-dioxins were the dominant congeners (Table 8).

Lake Ontario

Concentrations of 2,3,7,8-TCDD were above detection limits in 38 of the 51 edible portion samples of open lake data points. The concentrations ranged from <3.2 ng/kg 2,3,7,8-TCDD in suckers at Fort Niagara, NY to 162 ng/kg TCDD in brown trout at St. Catharines, Ontario (Table 6). Fourteen data points exceeded the applicable USFDA and Canadian guidelines of 25 and 20 ng/kg while the New York State Department of Health's guideline of 10 ng/kg was exceeded by 59 percent of the edible portion samples analyzed.

Concentrations of 2,3,7,8-TCDD in whole open lake fish ranged from 28 ng/kg in brook trout at Roosevelt Beach to 107 ng/kg in lake trout at Gallo Island. The concentrations in nearshore and tributary samples ranged from ND to 13.5 ng/kg with no clear distribution patterns. The presence of 2,3,7,8-TCDD at 7 ng/kg and 13.5 ng/kg in the young of the year spottail shiners from the Niagara River indicates site specific contamination problems, given the small size and short (6 to 8 months) exposure period of these fish. Only one sample from Lake Ontario (Roosevelt Beach) has been analyzed for dioxins other than TCDD. That sample was dominated by TCDD.

Table 6
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Ontario Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Open Lake							
Cape Vincent	White Perch	E	1/U	16	NA	NA	NYDEC/NYDOH 1978
	White Perch	E	1/U	36	NA	NA	NYDEC/NYDOH 1978
	White Perch	E	1/U	4.9	NA	NA	NYDEC/NYDOH 1978
Gallo Island	Lake Trout	W	1/U	107	NA	NA	NYDEC/NYDOH 1978
Salmon River	Chinook Salmon	E	1/U	39	NA	NA	NYDEC/NYDOH 1978
Credit River	Coho Salmon	E	1/U	20	NA	NA	NYDOC/NYDOH 1978
	Coho Salmon	E	1/U	19	NA	NA	NYDEC/NYDOH 1978
St. Catharines	Brown Trout	E	1/U	162	NA	NA	NYDEC/NYDOH 1978
Rochester	Brown Trout	E	1/U	30	NA	NA	NYDEC/NYDOH 1978
Nine Mile Point	Brown Trout	E	1/U	11,11	NA	NA	NYDEC/NYDOH 1978
	Brown Trout	E	1/U	8	NA	NA	NYDEC/NYDOH 1978
Cape Vincent	White Perch	E	1/U	9.9	NA	NA	NYDEC/NYDOH 1978
Salmon River	Rainbow Trout	E	1/U	20,21	NA	NA	NYDEC/NYDOH 1978
	Rainbow Trout	E	1/U	20	NA	NA	NYDEC/NYDOH 1979
	Rainbow Trout	E	1/U	9	NA	NA	NYDEC/NYDOH 1979
	Rainbow Trout	E	1/U	17,18	NA	NA	NYDEC/NYDOH 1979
Geren Point	White Perch	E	1/U	14	NA	NA	NYDEC/NYDOH 1979
Wilson	White Perch	E	1/U	31	NA	NA	NYDEC/NYDOH 1979
	White Perch	E	1/U	22	NA	NA	NYDEC/NYDOH 1979
	White Perch	E	1/U	7.7	NA	NA	NYDEC/NYDOH 1979
	White Perch	E	1/U	45	NA	NA	NYDEC/NYDOH 1979
Ft. Niagara	White Sucker	E	1/U	4.7	NA	NA	NYDEC/NYDOH 1979
	White Sucker	E	1/U	18	NA	NA	NYDEC/NYDOH 1979
	White Sucker	E	1/U	<3.2	NA	NA	NYDEC/NYDOH 1979
Lewiston	White Sucker	E	1/U	9.6	NA	NA	NYDEC/NYDOH 1979
	White Sucker	E	1/U	9.1	NA	NA	NYDEC/NYDOH 1979
Salmon River	Chinook Salmon	E	1/U	39	NA	NA	NYDEC/NYDOH 1979
	Chinook Salmon	E	1/U	26	NA	NA	NYDEC/NYDOH 1979
	Coho Salmon	E	1/U	31	NA	NA	NYDEC/NYDOH 1979
Springbrook	Coho Salmon	E	1/U	19	NA	NA	NYDEC/NYDOH 1979
	Coho Salmon	E	1/U	28	NA	NA	NYDEC/NYDOH 1979
Roosevelt Beach	Brook Trout	W	1/U	NA	33	33	USFWS 1979 (1)
Lower Niagara	American eel	E	5/1	<10	NA	NA	MOE 1980
	Walleye	E	1/1	<10	NA	NA	MOE 1980
	Rainbow Trout	E	1/1	<10	NA	NA	MOE 1980
	Yellow Perch	E	6/1	<10	NA	NA	MOE 1980
Jordan Harbor	Brown Trout	E	13/1	<10-19	NA	NA	MOE 1980
	White Bass	E	6/1	<10-19	NA	NA	MOE 1980
Credit River	Coho Salmon	E	8/1	<10	NA	NA	MOE 1980
Hearn Generating Station	Smelt	E	8/1	<10-11	NA	NA	MOE 1980

Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin
In Lake Ontario Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Scarborough	Lake Trout	E	5/1	<10-19	NA	NA	MOE 1980
Bay of Quinte	Yellow Perch	E	6/1	<10	NA	NA	MOE 1980
	White Perch	E	6/1	<10-16	NA	NA	MOE 1980
Port Credit	Lake Trout	E	1/U	24.4	NA	NA	MOE 1980
Toronto	Lake Trout	E	1/U	17.8	NA	NA	MOE 1980
	Smelt	E	1/U	8.0	NA	NA	MOE 1980
	Rainbow Trout	E	1/U	32	NA	NA	NYDEC/NYDOH 1980
Port Hope	Rainbow Trout	E	1/U	8.3	NA	NA	MOE 1980
Lower Niagara	Yellow Perch	E	1/U	6.6	NA	NA	NOE 1980
Burlington	Lake Trout	W	1/U	72	NA	NA	NYDEC/NYDOH 1980
Pt. Petre	Lake Trout	W	1/U	42	NA	NA	NYDEC/NYDOH 1980
Niagara	Lake Trout	W	1/U	41	NA	NA	NYDEC/NYDOH 1980
Springbrook	Coho Salmon	E	1/U	22	NA	NA	NYDEC/NYDOH 1980
	Coho Salmon	E	1/U	20	NA	NA	NYDEC/NYDOH 1980
	Coho Salmon	E	1/5	<10	NA	NA	GLNPO/USFDA 1981
	Coho Salmon	E	1/5	33/35	NA	NA	GLNPO/USFDA 1982
Nearshore and Tributary							
Lower Niagara	Northern Pike	E	6/1	<10	NA	NA	MOE 1980
	Muskellunge	E	1/1	<10	NA	NA	MOE 1980
	Smallmouth Bass	E	1/U	12.7	NA	NA	MOE 1980
	Rock Bass	E	1/U	2.4	NA	NA	MOE 1980
Pultneyville	Smallmouth Bass	E	1/U	7	NA	NA	NYDEC/NYDOH 1979
	Smallmouth Bass	E	1/U	4.8	NA	NA	NYDEC/NYDOH 1979
	Smallmouth Bass	E	1/U	5.9	NA	NA	NYDEC/NYDOH 1979
Rays Bay	Brown Bullhead	E	1/U	5	NA	NA	NYDEC/NYDOH 1979
Littel Fox Creek	Brown Bullhead	E	1/U	3.8	NA	NA	NYDEC/NYDOH 1979
Sodus Bay	Brown Bullhead	E	1/U	2	NA	NA	NYDEC/NYDOH 1979
Niagara River,							
Lewiston	Spotatil Shinner	W	7/10	ND	NA	NA	MOE 1981
Peggys Eddy	Spottail Shinner	W	7/10	7	NA	NA	MOE 1981
Queenston	Spottail Shinner	W	7/10	ND	NA	NA	MOE 1981
Niagara-on-the Lake	Spottail Shinner	W	7/10	13.5	NA	NA	MOE 1981

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 8

E = Edible portion
W = Whole fish

Midwest Lakes and Rivers

Samples from several Region V sites (other than the Great Lakes) have been analyzed for 2,3,7,8-TCDD and, in a limited number of cases, other dioxins. With the exception of the Mississippi and Wisconsin Rivers, 2,3,7,8-TCDD concentrations were below or near detection levels (Table 7). Composite samples of buffalo and channel catfish from the Mississippi River at St. Louis, Mo. contained 2,3,7,8-TCDD at 40 ng/kg and 100 ng/kg respectively. In the Wisconsin River, 2,3,7,8-TCDD in carp fillets ranged from 35 to 65 ng/kg at Pentenwell Flowage. Contamination of Wisconsin River fish with 2,3,7,8-TCDD has resulted in the Wisconsin Department of Natural Resources closing a large portion of the commerical fishery and advising sports fishmen not to consume the affected species.

Table 7
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in Fish From
Midwest Rivers and Lakes (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Kaskusia River (Illinois)	Channel Cat/ Carp	W	1/1 & 1	NA	ND	14	USEPA-Duluth 1980(1)
Great Miami River						18	
Greenhills, OH	Carp	W	1/4	NA	4	18	USEPA-Duluth 1980(1)
Hooven, OH	Channel Cat/ Carp	W	1/4 & 12	NA	2	17	USEPA-Duluth 1980(1)
Scioto River							
Columbus, OH (SouthWest of)	Black Crappie/ Carp	W	1/1 & 1	NA	2	24	USEPA-Duluth 1980(1)
Columbus, OH (Northwest of)	Sucker/Bass	W	1/2 & 2	NA	ND	17	USEPA-Duluth 1980(1)
Chillicothe East, OH	Carp	W	1/2	NA	ND	30	USEPA-Duluth 1980(1)
Mississippi River							
St. Louis, Mo.	Carp	E	1/3	<7	NA	NA	Syntex Corp. 1982
St. Louis, Mo.	Buffalo	E	1/3	40	NA	NA	Syntex Corp. 1982
St. Louis, Mo.	Channel Cat	E	1/3	100	NA	NA	Syntex Corp. 1982
Below St. Louis, Mo.	Buffalo	E	1/U	<10	NA	NA	USFDA 1982
Below St. Louis, Mo.	Buffalo	E	1/U	<10	NA	NA	USFDA 1982
Below St. Louis, Mo.	Buffalo	E	1/U	<10	NA	NA	USFDA 1982
Below St. Louis, Mo.	Catfish	E	1/U	<10	NA	NA	USFDA 1982
St. Genevieve, Mo.	Buffalo	E	1/U	<10	NA	NA	USFDA 1982
Chester, Il.	Buffalo	E	1/U	<10	NA	NA	USFDA 1982
Sartell, MN.	Carp	E	1/5	<5	NA	NA	USEPA-Duluth 1983
Red Wing, MN.	Carp	E	1/5	<5	NA	NA	USEPA-Duluth 1983
Spring Lake	Carp	E	1/5	<5	NA	NA	USFWS 1983
Pool 1011	Carp	W	1/5	ND	NA	NA	USEPA-Duluth 1983
Tuscarasus River							
RM 56.6. OH	Carp	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Channel Catfish	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Sugar Cr.							
RM 0.15, OH	Carp	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	BrownBullhead	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Channel Catfish	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Ohio River							
Marietta, OH	Suger	E	1/U				
	Carp	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Channel Catfish	E	1/U	<5	NA	NA	USEPA-Duluth 1984

Table 7 con't
Concentrations of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in Fish From
USEPA Region V Rivers and Lakes (ng/kg)

Location	Species	Sample Type	# of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Little Beaver Cr.							
Middle Fork, OH	Creek Chub	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Stone Roller	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	White Sucker	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Sunfish Cr.							
RM 5.0, OH	Black Redhorse	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Smallmouth Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Hocking River							
Sugar Grove, OH	White Sucker	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Carp	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Little Scioto River							
RM 12.6, OH	Spotted Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Golden Redhorse	E	1/U	<5	NA	NA	USEPA-Duluth 198
	Black Redhorse	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Little Muskingum River							
Dart, OH	Rockbass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Spotted Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Black Redhorse	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Smallmouth Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Golden Redhorse	E	1/U	<5	NA	NA	USEPA-Duluth 1984
		E					
Clear Creek							
RM 2.0, OH	White Sucker	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Smallmouth Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Still Water River							
RM 51.2, OH	Carp	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Rockbass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
North Fort Paint Ck.							
RM 17.6, OH	Carp	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Smallmouth Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
White Oak Cr.							
RM 12.8, OH	Golden Redhorse		1/U	<5	NA	NA	USEPA-Duluth 1984
	Smallmouth Bass		1/U	<5	NA	NA	USEPA-Duluth 1984
Blachard River							
RM 62.1, OH	White Sucker	E	1/U	<5	NA	NA	USEPA-Duluth 1984
	Rock Bass	E	1/U	<5	NA	NA	USEPA-Duluth 1984
Lake Delevan, WI	Carp	E	1/3	<2.0	NA	NA	WDNR 1983
Lake Koshkonong, WI	Carp	E	1/5	<5.0	NA	NA	WDNR 1983

Table 7 con't
Concentration of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in Fish From
USEPA Region V Rivers and Lakes (ng/kg)

Location	Species	Sample Type	# of Samples/ #Fish Per Sample	2,3,7,8 TCDD	Total TCDD	Total PCDD	Source
Lake Tichigan, WI	Carp	E	1/5	<5.0	NA	NA	WDNR 1983
Peddock Lake, WI	Carp	E	1/3	<3.0	NA	NA	WDNR 1983
Lac LaBelle, WI	Carp	E	1/2	<8.0	NA	NA	WDNR 1983
Fox River							
Portage, WI	Carp	E	1/7	<12.0	NA	NA	WDNR 1983
	Largemouth Bass	E	1/6	<10.0	NA	NA	WDNR 1983
Wisconsin R., WI							
Below Merrill Dam	Carp	E	1/3	<5	NA	NA	WDNR 1983
		E	1/2	<2	NA	NA	WDNR 1983
Mosinee Flowage	Walleye						
	Carp	E	1/5	<3	NA	NA	WDNR 1983
Wisconsin River	Walleye	E	1/5	<4	NA	NA	WDNR 1983
Pentennell Flowage	Buffalo	E	1/7	<2	NA	NA	WDNR 1983
	Walleye	E	1/5	<2	NA	NA	WDNR 1983
	Walleye	E	1/1	<10	NA	NA	WDNR 1983
	Carp	E	1/5	35	NA	NA	WDNR 1983
	Carp	E	1/5	65	NA	NA	WDNR 1983
	Carp	E	1/5	60	NA	NA	WDNR 1983
	Carp	E	1/5	65	NA	NA	WDNR 1983
	Carp	E	1/5	56	NA	NA	USEPA-Duluth 1983
Castle Rock Flowage	Carp	E	1/5	<5	NA	NA	WDNR 1983
	Walleye	E	1/6	<2	NA	NA	WDNR 1983
Lake Wisconsin	Walleye	E	1/3	<5	NA	NA	WDNR 1983
	Carp	E	1/5	<20	NA	NA	WDNR 1983
	Carp	E	1/5	21	NA	NA	USEPA-Duluth 1983
Agate Lake, MN.	Northern Pike	E	1/5	<5	NA	NA	USEPA-Duluth 1983
Minnesota River, MN.	Carp	E	1/5	<5	NA	NA	USEPA-Duluth 1983
Zumbro Lake, MN.	Channel Cat	E	1/5	<5	NA	NA	USEPA-Duluth 1983

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 8

E = Edible portion
W = Whole fish

Table 8
Polychlorinated Dibenzo Dioxions in Great Lakes and Midwest Fish (ng/kg)

Location	Species	Source	2cl	3cl	4cl	5cl	6cl	7cl	8cl	Total
Lake Superior										
Keweenaw	Bloater	USFWS 1979	NA	NA	ND	ND	ND	ND	ND	ND
Apostle Islands	Lake Trout	USFWS 1979	NA	NA	ND	ND	ND	ND	ND	ND
Grand Marais	Lake Trout/Salmon	USEPA-Duluth 1980	ND	<1	ND	ND	ND	ND	ND	<1
Copper Harbor	Lake Trout	USEPA-Duluth 1980	ND	<1	ND	ND	ND	ND	ND	<1
Ontonogon	Lake Trout	USEPA-Duluth 1980	ND	2	1	5	ND	ND	ND	8
Saginaw Bay										
Bay City	Carp	USFWS 1981	NA	NA	94	157	122	12	ND	385
Grid 1509	Carp	USFWS 1979	NA	NA	27	21	ND	31	32	111
Tittabawass River (Below Dow)	Carp	USFWS 1979	NA	NA	81	31	44	53	14	223
Lake Michigan										
Sagatuck	Lake Trout	USFWS 1979	NA	NA	5	ND	ND	ND	ND	5
Waukegan Harbor	Carp	USFWS 1981	NA	NA	ND	ND	ND	ND	ND	ND
	Largemouth Bass	USFWS 1981	NA	NA	ND	ND	3	ND	34	37
Lake Erie										
Port Clinton, MI	Carp	USFWS 1979	NA	NA	ND	9	ND	11	30	50
Lake St. Clair	Catfish	USEPA-Duluth 1980	ND	ND	7	5	6	17	ND	35
Woodtick, MI	Carp	USEPA-Duluth 1980	7	11	12	13	17	20	26	106
Lake Ontario										
Roosevelt Beach	Brook Trout	USFWS 1979	NA	NA	33	ND	ND	ND	ND	33
Region V Rivers and Lakes										
Kaskusia River	Channelcat/Carp	USEPA-Duluth 1980	ND	1	ND	ND	ND	ND	13	14
Great Miami River										
Greenhills, OH	Carp	USEPA-Duluth 1980	5	2	4	7	ND	ND	ND	18
Hooven, OH	Channelcat/Carp	USEPA-Duluth 1980	ND	2	2	3	4	6	ND	17
Scioto River										
Columbus, OH		USEPA-Duluth 1980	ND	<1	2	12	ND	ND	10	24
(Southwest of)	Black crappie/carp	USEPA-Duluth 1980	ND	ND	ND	ND	ND	ND	17	17
(Northwest of)	Sucker/bass									
Chillicothe East	Carp	USEPA-Duluth 1980	ND	<1	ND	ND	5	8	17	30

NA = Not Analyzed
ND = Not Detected

(Data is not isomer specific)

POLYCHLORINATED DIBENZO FURANS

Tables 9 through 14 contain the data on 2,3,7,8-Tetrachlorodibenzo furans (2,3,7,8-TCDF) and, where data on additional congeners is available, total tetrachlorodibenzo furans (TCDF) and total polychlorinated dibenzo furans (PCDF). Table 15 contains the available data on individual PCDF congeners.

Lake Superior

Five open lake samples from 5 locations in Lake Superior and Isle Royal have been analyzed for PCDF's. Concentrations of TCDF ranged from ND at Ontonogon to 26 ng/kg in Keweenaw Bay with 4 of the 5 samples above detection limits (Table 9). Total PCDF ranged from ND to 40 ng/kg with TCDD predominant. Lake trout from Siskiwet Lake (Isle Royal) contained 15 ng/kg total PCDF, 10 ng/kg of which was TCDF (Table 15).

Lake Huron

The entire Lake Huron open lake data base consists of one composite sample of lake trout taken off Rockport (Alpena, Michigan). That sample contained 25.5 ng/kg TCDF and 80.5 ng/kg total PCDF (Table 10). The primary PCDF was penta CDF (Table 15). Saginaw Bay and its tributaries are represented by 3 carp composites with TCDF concentrations ranging from 5 to 37 ng/kg. PCDF in Saginaw Bay samples ranged from 29 to 290 ng/kg (Table 10) with penta and hexa CDF's the dominant congeners (Table 15).

Lake Michigan

A total of 7 samples from 7 open lake areas of Lake Michigan and Green Bay have been analyzed for PCDFs. The nearshore and tributary data base consists of 7 samples from 6 sites. 2,3,7,8-TCDF was found in all open lake samples at concentrations ranging from 22 ng/kg to 90 ng/kg (Table 11).

Table 9
Concentrations of 2,3,7,8-Tetrachlorodibenzo Furans
In Lake Superior Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDF	Total TCDF	Total PCDF	Source
Open Lake							
Keweenaw Bay	Bloater	W	1/5	NA	26	40	USFWS 1979(1)
Apostle Islands	Lake Trout	W	1/5	NA	19	40	USFWS 1979(1)
Isle Royale Lake Siskiwit	Lake Trout	W	1/5	NA	10	15	USFWS 1980(1)
Ontonogon	Lake Trout	W	1/1	NA	ND	ND	USEPA-Duluth 1980(1)
Copper Harbor	Lake Trout	W	1/2	NA	2	2	USEPA-Duluth 1980(1)

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional congeners in Table 15

E = Edible portion
W = Whole fish

Table 10
Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan
In Lake Huron Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDF	Total TCDF	Total PCDF	Source
Open Lake							
Rockport, MI	Lake Trout	W	1/5	NA	25.5	80.5	USFWS 1981(1)
Nearshore and Tributary							
Saginaw Bay							
Bay city	Carp	W	1/1	27	NA	153	USFWS 1981
Grid 1509	Carp	W	1/U	5	NA	29	USFWS 1979
Tittabawasse River (Below Dow)	Carp	W	1/U	37	NA	290	USFWS 1979

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 15

E = Edible portion
W = Whole fish

Table 11
Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan
In Lake Michigan Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDF	Total TCDF	Total PCDF	Source
Open Lake							
Saugatuck	Lake Trout	W	1/5	35	NA	86	USFWS 1979(1)
Green Bay							
Grid 1001	Walleye	E	1/5	56	NA	NA	WDNR 1984
Little Sturgen Bay	Walleye	E	1/5	35	NA	NA	WDNR 1984
Strawberry Ck. WI	Chinook	E	1/2	22	NA	NA	WDNR 1984
Gills Rock, WI	Lake Trout	E	1/2	80	NA	NA	WDNR 1984
Sheboygan River	Chinook	E	1/1	24	NA	NA	WDNR 1984
Kenosha, WI	Lake Trout	E	1/2	90	NA	NA	WDNR 1984
Nearshore and Tributary							
Waukegan Harbor	Carp	W	1/1	NA	29	32	USFWS 1981(1)
	Largemouth Bass	W	1/1	NA	68	98	USFWS 1981(1)
Green Bay							
Kidney Is.	Carp	E	1/2	10	NA	NA	WDNR 1984
Little Sturgeon Bay	Carp	E	1/5	<10	NA	NA	WDNR 1984
Milwaukee River							
North Avenue	Carp	E	1/3	<8	NA	NA	WDNR 1984
Sheboygan River	Carp	E	1/3	<10	NA	NA	WDNR 1984
Fox River	Carp	E	1/7	<10	NA	NA	WDNR 1984

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 15

E = Edible portion
W = Whole fish

Nearshore and tributary samples were above detection limits for TCDF at Waukegan Harbor (IL), and Kidney Island (Green Bay), ranging from 10 to 68 ng/kg (Table 11). Total PCDF was 32 and 98 ng/kg in the 2 samples in which other PCDFs were analyzed. Tetra and penta PCDF were the dominant congeners in these samples (Table 15).

Lake Erie

Two open lake (whole walleye) samples from Lake Erie and Lake St. Clair contained 18 and 4 ng/kg TCDD and 40 and 12 ng/kg PCDF, respectively. Nearshore and tributary samples from Port Clinton (MI), Woodtick (MI) and Lake St. Clair yielded TCDD results ranging from 5 to 16 ng/kg (Table 12). Total PCDF in the nearshore and tributary samples ranged from 18 to 37 ng/kg with tetra and penta PCDF the dominant forms (Table 15).

Lake Ontario

The two open lake samples from Lake Ontario contained 19 and 34 ng/kg TCDF (Table 13) respectively with total PCDF concentrations of 32 and 119 ng/kg, tetra CDF and penta CDF were the most abundant congeners. No nearshore and tributary samples from Lake Ontario have been analyzed for PCDF.

Midwestern Rivers and Lakes

Fish from 8 sites in Wisconsin, Illinois and Ohio have been analyzed for PCDF (Table 14). Concentrations of TCDF range from ND in the single sample from the Great Miami River to 45 ng/kg in Petenwell Flowage, Wisconsin. The contribution of the various congeners to the total PCDF is given in Table 15.

Table 12

Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan
In Lake Erie Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDF	Total TCDF	Total PCDF	Source
Open Lake							
Cedar Point	Walleye	W	1/5	NA	18	40	USFWS 1979 (1)
Lake St. Clair Anchor Bay	Walley	W	1/5	NA	4	12	USFWS 1981 (1)
Nearshore and Tributary							
Port Clinton, MI	Carp	W	1/3-5	NA	5	18	USFWS 1979 (1)
Lake St. Clair	Catfish	W	1/U	NA	16	33	USEPA-Duluth 1980 (1)
Woodtick, MI	Carp	W	1/3	NA	8	37	USEPA-Duluth 1980 (1)

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 15

E = Edible portion
W = Whole fish

Table 13
Concentrations of 2,3,7,8-Tetrachlorodibenzo Furan
In Lake Ontario Fish (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDF	Total TCDF	Total PCDF	Source
Open Lake							
Oswego, N.Y	Lake Trout	W	1/5	NA	34	119	USFWS 1979(1)
Roosevelt Beach	Brook Trout	W	1/1	NA	19	32	USFWS 1979(1)

NA = Not Analyzed
ND = Not Detected
U = Unknown
(1) Data for Additional Congeners in Table 15

E = Edible portion
W = Whole fish

Table 14
Concentrations of 2,3,7,8-Tetrachlorodibenzo Furans
In Fish From Midwest Rivers and Lakes (ng/kg)

Location	Species	Sample Type	#of Samples/ #Fish Per Sample	2,3,7,8 TCDF	Total TCDF	Total PCDF	Source
Lake Pepin, WI	Walleye	E	1/3	25	NA	NA	WDNR 1984
	Carp	E	1/3	20	NA	NA	WDNR 1984
Wisconsin River							
Mosinee Flowage	Carp	E	1/5	<15	NA	NA	WDNR 1984
Petenwell Flowage	Buffalo	E	1/7	15	NA	NA	WDNR 1984
	Walleye	E	1/1	15	NA	NA	WDNR 1984
	Walleye	E	1/5	45			
	Carp	E	1/5	25	NA	NA	WDNR 1984
	Carp	E	1/5	25	NA	NA	WDNR 1984
Castle Rock Flowage	Carp		1/5	30	NA	NA	WDNR 1984
	Walleye		1/6	16	NA	NA	WDNR 1984
Kaskusia River							
Red Bud, OH	Channel Cat/ Cat	E	1/U	NA	4	7	USEPA-Duluth 1980(1)
Scioto River							
Chillicothe East, OH	Carp	E	1/U	NA	3	3	USEPA-Duluth 1980(1)
Columbus,OH (Southwest of)	Black Crappie/ Carp	E	1/U	NA	4	32	USEPA-Duluth 1980(1)
(Northwest of)	Sucker/bass	E	1/U	NA	ND	ND	USEPA-Duluth 1980(1)
Great Miami River							
Hooven, OH	Channel Cat/Carp	E	1/U	NA	ND	2	USEPA-Duluth 1980(1)

NA = Not Analyzed
ND = Not Detected
U = Unknwon
(1) Data for Additional Congeners in Table 15

E = Edible portion
W = Whole fish

Table 15

Polychlorinated Dibenzo Furans in Great Lakes and Midwest Fish (ng/kg)

Location	Species	Source	2cl	3cl	4cl	5cl	6cl	7cl	8cl	Total
Lake Superior										
Keweenaw	Bloater	USFWS 1979	NA	NA	26	9	2	1	2	40
Apostle Islands	Lake Trout	USFWS 1979	NA	NA	19	5	5	4	3	40
Isle Royal Lake Siskiwit	Lake Trout	USFWS 1980	NA	NA	10	5	ND	ND	Trace	15
Ontonogon	Lake Trout	USEPA-Duluth 1980	ND	ND	ND	ND	ND	ND	ND	ND
Copper Harbor	Lake Trout	USEPA-Duluth 1980	ND	ND	2	ND	ND	ND	ND	2
Lake Huron										
Rockport	Lake Trout	USFWS 1981	NA	NA	25.5	28.5	16	6.5	4	80.5
Saginaw Bay Bay City	Carp	USFWS 1981	NA	NA	27	44	34	44	4	153
Grid 1509	Carp	USFWS 1979	NA	NA	5	12	5	6	1	29
Tittabawasse R. (Below Dow)	Carp	USFWS 1979	NA	NA	37	73	145	31	4	290
Lake Michigan										
Sagatuck	Lake Trout	USFWS 1979	NA	NA	35	41	8	1	1	86
Waukegan Harbor	Carp	USFWS 1981	NA	NA	29	3	ND	ND	ND	32
	Largemouth Bass	USFWS 1981	NA	NA	68	28	2	ND	ND	98
Lake Erie										
Cedar Point	Walleye	USFWS 1979	NA	NA	18	9	6	5	2	40
Port Clinton, MI	Carp	USFWS 1979	NA	NA	5	5	2	4	2	18
Lake St. Clair Anchor Bay	Walleye	USFWS 1979	NA	NA	4	4	<1	<1	3	12
St. Clair	Catfish	USEPA-Duluth 1980	ND	ND	16	17	ND	ND	ND	33
Woodtick, MI	Carp	USEPA-Duluth 1980	ND	ND	8	29	ND	ND	ND	37
Lake Ontario										
Roosevelt Beach	Brook Trout	USFWS 1979	NA	NA	19	4	3	3	3	32
Oswego, NY	Lake Trout	USFWS 1979	NA	NA	34	48	29	6	2	119

Table 15 Con't

Polychlorinated Dibenzo Furans in Great Lakes and Midwest Fish (ng/kg)

Location	Species	Source	2cl	3cl	4cl	5cl	6cl	7cl	8cl	Total
Region V Rivers & Lakes										
Kaskusia River										
Red Bud, OH	Channel Cat/Carp	USEPA-Duluth 1980	ND	3	4	ND	ND	ND	ND	7
Great Miami River										
Hooven, OH	Channel Cat/Carp	USEPA-Duluth 1980	2	ND	ND	ND	ND	ND	ND	2
Scioto River										
Columbus, OH										
(Southwest of)	Black Crappie/Carp	USEPA-Duluth 1980	1	ND	4	13	9	5	ND	32
(Northwest of)	Sucker/Bass	USEPA-Duluth 1980	ND	ND	ND	ND	ND	ND	ND	ND
Chillicothe East, OH	Carp	USEPA-Duluth 1980	ND	ND	ND	3	ND	ND	ND	3

NA = Not Analyzed
ND = Not Detected

DISCUSSION

The collective PCDD and PCDF data base, while substantial, suffers from severe limitations. Little coordination has existed between studies, resulting in differences in species, sample portion, sample size, collection season and parameters monitored. This is exacerbated in many cases by the absence of accurate ancillary data such as length, weight and lipid content. The emphasis of many studies on criteria compliance has resulted in most samples being analyzed for only 2,3,7,8-TCDD, the only isomer of either group for which criteria exist. The data for PCDD's and PCDF's other than 2,3,7,8-tetra, is congener specific with no information on specific isomers. These limitations preclude any rigorous analysis of data, however, some generalizations may be made.

With the exception of Lake Ontario and Saginaw Bay, concentrations of 2,3,7,8-TCDD in open lake samples are low, being at or near analytical detection limits. Contamination in Saginaw Bay appears confined to the southern portion of the Bay, primarily near and in the current pattern of the Saginaw River. All areas of Lake Ontario were contaminated, with 59 percent of the samples analyzed exceeding the NYDOH guideline of 10 ng/kg. The nearshore and tributary data for TCDD indicate several localized areas of concern. These include Grand River (Lake Michigan) Niagara River (Lake Ontario), Woodtick, (Lake Erie), Huron River, MI, (Lake Erie), Port Clinton, MI (Lake Erie) and Saginaw Bay and its tributaries the Saginaw, Tittabawassee and Pine Rivers. Additional problem areas outside the Great Lakes Basin include the Petenwell Flowage, area of the Wisconsin River and the Mississippi River at St. Louis, Mo.

Beyond a level of consistency in study design that would allow geographical and temporal comparisons, the most serious short comings of the existing data base are the absence of isomer specific data on PCDD's other than 2,3,7,8-TCDD and a lack of PCDF data.

While most studies have been directed at 2,3,7,8-TCDD the limited data on other PCDD congeners indicate that the contribution of TCDD to the total PCDD varies widely and that frequently that contribution is small. In 18 of the 21 samples which have been analyzed for additional PCDD congeners, TCDD represents less than 30 percent of the total PCDD concentration. Penta CDD concentrations are frequently higher than TCDD.

Few samples have been analyzed for 2,3,7,8-TCDF and even fewer for other PCDF congeners. However, those samples which have been analyzed indicate that 2,3,7,8-TCDF occurs with alarming frequency. Over 80 percent of the samples which have been analyzed contained 2,3,7,8-TCDF above analytical detection limits. PCDF's occurred in both "nearshore and tributary" and "open lake" species from each of the Great Lakes suggesting that PCDF's may be ubiquitous in the Great Lakes system. This is also suggested by its occurrence in fish from Lake Siskiwit (Isle Royal, Lake Superior) (Stalling et at. 1983) where the most likely input route is atmospheric deposition (Swain 1980).

The significance of the absence of data for PCDFs and for PCDDs other than 2,3,7,8-TCDD lies in the toxicity of specific isomers within each group. It is well known that both dioxins and furans having 4 to 6 chlorines and at least 3 lateral (2,3,7,8) positions substituted with chlorine are extremely toxic (Jones 1981). Included in this group are 2,3,7,8-tetra-CDD, 1,2,3,7,8-penta-CDD, 1,2,3,6,7,8-hexa-CDD, 1,2,3,7,8,9-hexa-CDD 1,2,3,4,7,8-hexa-CDD as well as 2,3,7,8-tetra-CDF, 1,2,3,7,8-penta-CDF, 2,3,4,7,8-penta-CDF, 1,2,3,6,7,8-hexa-CDF 1,2,3,7,8,9-hexa-CDF and 2,3,4,6,7,8-hexa-CDF (Rappe 1984). Of these 2,3,7,8-tetra-CDD, 1,2,3,7,8-penta-CDD, 2,3,7,8-tetra-CDF and 2,3,4,7,8-penta-CDF are particularly toxic with LD50 values for guinea pigs less than 10 ug/kg (Rappe 1984).

Due to the toxicity of PCDD's other than TCDD (particuarly penta CDD) and the apparent wide spread occurrence of PCDF's, efforts should be made to develop criteria and expand monitoring programs to include these compounds.

Table 16

Data Contributors

GLNPO/USFDA	=	U.S. Environmental Protection Agency, (Great Lakes National Program Office) and U.S. Food and Drug Administration. Great Lakes Fish Monitoring Program, Great Lakes National Program Office Chicago, Illinois
MOE	=	Ministry of the Environment Ontario, Toronto, Ontario Canada
MSU	=	Michigan State University East Lansing, Michigan
NYDEC/NYDOH	=	State of New York Department of Environmental Conservation, New York Department of Health Albany, New York
Syntex Corp	=	Syntex Corp. Palo Alto, California
USEPA-Duluth	=	U.S. Environmental Protection Agency Environmental Research Laboratory Duluth, Minnesota
USEPA	=	U.S. Environmental Protection Agency Research Triangle Park, North Carolina
USFDA	=	U.S. Food and Drug Administration Detroit, Michigan
USFWS	=	U.S. Fish and Wildlife Service Columia National Fisheries Laboratory Columia, Missouri
WDNR	=	Wisconsin Department of Natural Resources Madison, Wisconsin
WSU	=	Wright State University Dayton, Ohio

Literature Cited

Jones, P.A. 1981. Chlorophenol and their imparities in the Canadian Environment Report EPA 3-EC-81-2. Environment Canada, Ottawa, Canada. 434 p.

O'Keefe, P., C. Meyer, D. Hilker, K. Aldous, B. Jelus-Tyror, K. Dillion, R. Donnelly, E. Horn and R. Sloan. 1983. Analysis of 2,3,7,8-Tetrachloro-Dibenzo-p-Dioxin in Great Lakes Fish. Chemosphere. 12: 325-332.

Poland, A., W.F. Greenlee and A.S. Kende. 1979. Studies on the Mechanism of Action of the Chlorinated dibenzo-p-dioxins and related compounds. Ann. N.Y. Acad. Sci. 320: 214-230.

Rappe, C., H.R. Buser and H.P. Bosshardt. 1979. Dioxins, dibenzofurans and other polyhalogenated Aromatics; Production, use, Formation and destruction. Ann. N.Y. Acad Sci. 320:1-18.

Rappe, C. 1984. Analysis of Polychlorinated Dioxins and Furans. Eviron. Sci. Technol. 18:78-91.

Rohrer, T.K., J.H. Hartig and j.C. Forney. 1981. Organochlorine and Heavy Metal Residues inCoho an Chinook Salmon of the Great Lakes - 1980. MDNR Publ. No. 3730-0031. Michigan Department of Natural Resources. 23p.

Stalling, D.L., L.M. Smith, J.D. Petty, J.W. Hogan, J.L. Johnson, C. Rappe, and H.R. Buser. 1983. Residues of Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans in Laurentian Great Lakes Fish. in. Human and Environmental Risks of Chlorinated Dioxins and Related Compounds. R.E. Tucker, Alvin L. Young and Allan P. Gray, Eds. Plenum Publishing Co.

Swain, W.R. 1980. Chlorinated Organic Residues in Fish, Water and Precipitations From the Vicinity of Isle Royal, Lake Superior. J. Great Lakes 4:398-407.

EPA

In Fish from the Great Lakes and Midwest

United States
Environmental Protection
Agency

Great Lakes National
Program Office
536 South Clark Street
Chicago, IL 60605

Official Business
Penalty for Private Use
$300.00

U.S.EPA 5, Graphic Arts, 1984